PNM San Juan Generating Station
Refined BART Visibility Results
March 31, 2008

Introduction

In a letter dated December 21, 2007, the New Mexico Environmental Department – Air Quality Bureau (NMED) requested additional modeling analyses be performed. Following the receipt of the NMED letter, PNM and Black & Veatch have discussed the request with NMED and determined the subsequent analyses were to include plant-wide and unit specific class I modeling. Subsequent to the June 2007 submittal, PNM further investigated additional refinements to the BART CALPUFF air dispersion modeling analyses which included nitrate repartitioning and more realistic ammonia background concentrations based on monitored values at several western Class I areas. These analyses were submitted in November 2007.

To date, PNM has previously submitted two BART modeling analyses. To clarify the contents of these analyses, as well as for this submittal, a summary of each has been provided:

June 6, 2007

Modeling analysis was performed to provide SJGS plant-wide regional haze (visibility) impacts at 16 Class I areas. The analysis was based on a constant 1 ppb background ammonia concentration and no nitrate repartitioning.

November 6, 2007

Modeling analysis was performed to provide SJGS plant-wide regional haze (visibility) impacts at 16 Class I areas. The analysis was based on refinements which included using the nitrate repartitioning methodology and monthly variable background ammonia concentrations.

March 31, 2008

Two main modeling analyses were performed to provide SJGS plant-wide and unit specific regional haze (visibility) impacts at 16 Class I areas. One of the analyses, believed to be the more representative of ammonia chemistry of the area, was based on the November 6, 2007 refinements which included using the nitrate repartitioning methodology and monthly variable background ammonia concentrations. The other analyses included nitrate repartitioning and a constant background ammonia concentration as requested by the NMED.

NMED EX. 7k

The modeling refinements contained in this submittal using nitrate repartitioning and the variable ammonia background, as well as the November 2007 submittal, supersedes the original June 2007 BART modeling analyses as PNM believes these analyses are more representative. Therefore, the purpose of this document is to first, summarize the two refinements used and to provide supplemental information on the background ammonia data. Second, the document will summarize the SJGS plant-wide and unit specific modeling using nitrate repartitioning and a both a variable and constant ammonia background.

Nitrate Repartitioning

The first refinement for the SJGS BART visibility analyses (included in the November 2007 submittal) was to better account for the amount of particulate nitrate (NO_3) by limiting the available ammonia when individual unit puffs overlap. The original visibility modeling did not incorporate repartitioning of available ammonia (MNITRATE = 0). The refinements did not allow each overlapping puff(s) to use the full ammonia background value but instead only a portion of the ammonia available (MNITRATE = 1). This concept is reflected in Section 3.1.2.6 of the WRAP protocol. It is important to note that this refinement noted as nitrate repartitioning is not the ammonia limiting method commonly referred to as ALM.

Ammonia Background Concentration

As described in Section 8.1 of the BART application, the air dispersion modeling analyses presented were conducted in accordance with the *CALMET/CALPUFF Protocol for BART Exemption Screening Analysis for Class I Areas in the Western United States* dated August 15, 2006, (hereinafter referred to as the WRAP Protocol). Specifically, the SJGS BART modeling was performed using the same high fixed background ammonia level of 1 ppb that was used for the initial modeling performed by WRAP RMC. However, there is limited real-time or historic ambient concentration information for ammonia within the modeling domain and at the individual Class I areas from sources such as CASNET. As a result, there is limited information to use to verify whether the assumed 1 ppb ammonia background concentration is representative. In fact, colder temperatures and limited agriculture activity, among other variables, could limit the amount of ammonia present in the ambient atmosphere, thus limiting the ammonia available to chemically react to form sulfates and nitrates to reduce visibility. Section 3.1.2.6 of WRAP protocol indicates that the 1 ppb value would be initially used and the issue revisited at a later time:

Thus, based on the fact that western Class I areas tend to be either more arid or forest land than grassland we proposed to initially use a 1 ppb background ammonia value for the CALPUFF runs. We will then revisit the background ammonia values for the Class I areas for the post processing step and provide the CALPUFF output to the States so they can investigate alternative background ammonia values if desired.

No additional information from the WRAP regarding refined ammonia background concentrations was available. Therefore, an investigation was undertaken to locate more realistic ammonia background values. The Sithe Global Power, LLC's Desert Rock Energy Facility and the Toquop Energy Project visibility analyses located in the southwestern U.S. used variable monthly background ammonia concentrations. Based on this information, refinements to SJGS's BART modeling (included in the November 2007 submittal) reflected these previously used and approved values. These background ammonia concentrations are presented in Table 1 for reference. Additionally, the aforementioned ammonia data and supporting information for the values contained in Desert Rock Energy Facility and the Toquop Energy Project visibility analyses have been included in Attachment 1. These data were based on ammonia background concentrations monitored at several western class I areas.

Table 1
Variable Monthly Ammonia Background Concentration

Month	Background Ammonia Concentration (ppb)
January	0.2
February	0.2
March	0.2
April	0.5
May	0.5
June	1.0
July	1.0
August	1.0
September	1.0
October	0.5
November	0.5
December	0.5

Visibility Summary

Based on the aforementioned refinements in background ammonia concentrations and nitrate repartitioning, revised CALPUFF visibility modeling was performed for three cases; pre-consent decree, consent decree (which represents SJGS's BART baseline scenario), and the SCR control technology scenario. The modeling summarized in this report is for the SJGS on a plant-wide basis and for each of the four SJGS units on an individual unit basis. It is important to note that all other modeling options as described in the BART application were unchanged. For simplicity, the following results discuss the differences between the consent decree scenario and the SCR scenario. The visibility modeling results are contained in Attachment 2.

SJGS Visibility Summary with Nitrate Repartitioning and Variable Ammonia

The results of the refined visibility modeling for the SJGS plant, assuming the same control technology is installed on all four units, are illustrated in Tables 1 through 4 of Attachment 2. These tables summarize the scenarios and the maximum visibility (deciview) impact seen at any of the 16 Class I areas at any time over the 2001 to 2003 period. The results of this analysis, using the aforementioned refinements, indicates a decrease in visibility impact at each of the 16 Class I areas from those visibility impacts indicated in the BART application document. Of particular interest, the visibility impacts at Mesa Verde represent the maximum visibility impact at any of the Class I areas. However, these impacts also decrease from those impacts previously reported. *For the SCR control scenario, the visibility impacts are greater than either the pre-consent decree or the consent decree's visibility impact. Thus, there is no visibility improvement realized.*

The maximum visibility (deciview) improvement seen at any of the 16 Class I areas at any time over the 2001 to 2003 period is illustrated in Table 4 for each scenario. The expected degree of visibility improvement for each control scenario for each unit (on a plant-wide basis) was determined by the difference in the maximum visibility improvement for each receptor at each of the sixteen Class I areas. Again, it is important to note that the control technology associated with the consent decree formulated the SJGS's baseline case, as well as the baseline case for the individual unit analyses described later. Additionally, the cost-effectiveness for the potential BART control technologies from the BART application were used to calculate visibility improvement cost-effectiveness in $/deciview ($/dv). Three major scenarios are shown in the visibility improvement cost effectiveness summary in Table 4:

- Pre-consent decree to consent decree.
- Consent decree to additional SCR NO_x control technology alternatives scenario.

- Pre-consent decree to additional SCR NO_x control technology alternatives scenario.

These maximum visibility improvements between the consent decree and the SCR control scenario range from 0.08 dv to 0.38 dv of expected visibility improvement above the consent decree scenario. The results indicate that adding additional SCR NO_x control technology beyond the consent decree does not yield visibility improvement greater than 0.5 dv at any Class I area and in fact results in reduced visibility in some Class I areas.

Based on the visibility improvement modeled and the total annual cost evaluated in the impact analysis stage of the BART application document, the cost-effectiveness for visibility improvement (annual cost per improvement in visibility, $/dv), was determined for SJGS over the aforementioned range of visibility improvement. The resulting cost for installation of SCRs for all four units ranges from $1.2 billion/dv to $256 million/dv.

Attachment 2 contains a SJGS plant-wide summary of the 98th percentile visibility impact for the three modeled technology scenarios (i.e., Pre-Consent Decree, Consent Decree, SCR scenarios), provides information on the number of days above 0.5 dv threshold, and indicates the contribution of each pollutant associated with the 98th percentile visibility impact for each class I area.

Unit Specific Visibility Summary with Nitrate Repartitioning and Variable Ammonia

The results of the refined visibility modeling for Unit 1, Unit 2, Unit 3, and Unit 4 are illustrated in Tables 5-8, 9-12, 13-16, and 17-20 of Attachment 2, respectively. These tables summarize the scenarios and the maximum visibility (deciview) impact seen at any of the 16 Class I areas at any time over the 2001 to 2003 period. Similar to results seen for the SJGS facility, the visibility impacts at Mesa Verde represent the maximum visibility impact at any of the Class I areas. For the SCR control scenario, the visibility impacts at Mesa Verde are greater than the consent decree's visibility impact. Thus, there is no visibility improvement realized. It is important to note that individual unit impacts (both increases and decreases) at a specific class I area cannot be added to equal the combined SJGS plant-wide impact at the same class I area because each impact may not have occurred during the same 24 hour period or at the same receptor location.

The maximum visibility (deciview) improvement seen at any of the 16 Class I areas at any time over the 2001 to 2003 period is illustrated in Tables 8, 12, 16, and 20. Again, the expected degree of visibility improvement for each control scenario for each unit was determined by the difference in the maximum visibility improvement for each receptor at each of the sixteen Class I areas. Furthermore, the same methodology previously described for the SJGS's cost-effectiveness in ($/dv) was used here for each unit.

These maximum visibility improvements between the consent decree and the SCR control scenario for each unit are similar to that of the combine SJGS. The visibility improvements are summarized below.

- Unit 1 improvements range from 0.03 dv to 0.34 dv.
- Unit 2 improvements range from 0.03 dv to 0.33 dv
- Unit 3 improvements range from 0.05 dv to 0.37 dv
- Unit 4 improvements range from 0.05 dv to 0.37 dv

The results again indicate that adding additional SCR NO_x control technology beyond the consent decree does not yield visibility improvement greater than 0.5 dv at any Class I area. Based on the visibility improvement modeled and the total annual cost evaluated in the impact analysis stage of the BART application document, the cost-effectiveness for visibility improvement (annual cost per improvement in visibility, $/dv), was determined for each unit. The resulting cost for installation of SCRs for each unit is summarized below.

- Unit 1 cost range is $684 million/dv to $60 million/dv.
- Unit 2 cost range is $730 million/dv to $66 million/dv.
- Unit 3 cost range is $567 million/dv to $77 million/dv.
- Unit 4 cost range is $532 million/dv to $72 million/dv.

Attachment 2 contains a unit specific summary of the 98^{th} percentile visibility impact for the three modeled technology scenarios (i.e., Pre-Consent Decree, Consent Decree, SCR scenarios), includes the number of days above 0.5 dv threshold, and indicates the contribution of each pollutant associated with the 98^{th} percentile visibility impact for each class I area.

Visibility Summary with Nitrate Repartitioning and Constant Ammonia

As previously noted, the purpose of this analyses, and the November 2007 analysis, was to perform visibility modeling using refined methodologies from those contained in the original BART submittal. However, PNM recognizes that NMED has requested additional visibility modeling be conducted using a constant ammonia background value of 1 ppb. While PNM does not believe analyses conducted using the constant ammonia background (1 ppb) is representative, analyses have been conducted based on the aforementioned modeling methodology and described scenarios for both the SJGS plant and individual units.

Similar to results described previously, the visibility impacts at Mesa Verde represent the maximum visibility impact at any of the Class I areas. For the SJGS plant, for the SCR control scenario, the visibility impacts at Mesa Verde are greater than the consent decree's visibility impact and therefore, there is no visibility improvement realized. The individual unit's impacts for the SCR control scenario at Mesa Verde indicate a slight improvement in visibility from the consent decree. Specifically, Unit 1 and 2's individual improvements are at 0.5 dv while Unit 3 and 4's individual improvements are less than 0.5 dv. Again, individual unit impacts (both increases and decreases) at a specific class I area cannot be added to equal the combined SJGS plant-wide impact at the same class I area as each impact may not have occurred during the same 24 hour period or same receptor location.

For those Class I areas within New Mexico, 94 percent of the potential visibility improvements are less than 0.5 dv.

Attachment 2 contains tables summarizing the modeling results, the summary of the 98th percentile visibility impact for the three modeled technology scenarios (i.e., Pre-Consent Decree, Consent Decree, and SCR scenarios), and the number of days above 0.5 dv threshold and the contribution of each pollutant associated with the 98th percentile visibility impact for each class I area.

Additional Considerations

The minimal visibility improvements discussed in this document for either the variable or constant ammonia cases do not merit the large capital expenditure required to install SCR. In addition to the prohibitive cost associated with SCR, there are other important reasons that LNB, OFA and NN should be considered BART for the SJGS units. First, the LNB, OFA and NN systems being installed to meet the consent decree are state-of-the-art combustion controls. State-of-the-art combustion controls comprising of LNB, OFA and NN technologies were used to form the basis for the BART presumptive limits for NO_x in the BART guidelines. Second, installation of SCR requires ammonia to reduce NO_x emissions. Specifically, in a SCR system, ammonia is injected into the flue gas stream just upstream of a catalytic reactor. The ammonia molecules in the presence of the catalyst dissociate NO_x into nitrogen and water. Any unreacted ammonia passes through the reactor and out the stack as ammonia emissions or ammonia slip. This additional ammonia would then be available to add to the ammonia background concentration, chemically react to form nitrates and sulfates, and potentially further increase the visibility impacts at the Class I areas. The additional ammonia slip was not considered in this analysis. Finally, the visibility results imply that visibility is influenced more by the SJGS's sulfur emissions (SO_2 and additional SO_3 from the NO_x control devices) than by the reduction of NO_x. However, sulfur emissions are not subject to BART requirements because New Mexico participates in the WRAP emissions trading program. Therefore, LNB, OFA and NN should be considered BART for NO_x control on the SJGS units.

Conclusion

As noted in this document, PNM's further investigation of additional refinements to the June 2007 BART CALPUFF air dispersion modeling analyses to yield more realistic regional haze impacts was warranted. These analyses included nitrate repartitioning and more realistic ammonia background concentrations based on monitored values at several western Class I areas. The modeling refinements contained in this submittal, as well as the November 2007 submittal, supersedes the original June 2007 BART modeling analyses.

The conclusion of this study re-iterate and support the overall findings of the June 2007 that installation of SCR systems at the SJGS provide minimal visibility improvements and would require significant capital expenditure and modifications that will impact many areas of the plant including boiler draft systems, air heater performance, SO_3 emissions, and ash handling. The results from the analyses further substantiate that the addition of SCR technology does not yield a benefit nor meet the intended goal of BART. Specifically, these analyses indicate:

- The addition of SCR technology to SJGS shows an increase in visibility impact (i.e. visibility degradation) in some class I areas. This effect of SCR's is most pronounced at Mesa Verde, the closest Class I area which shows degradation over both the consent decree and pre-consent decree cases.
- The addition of SCR technology on a plant-wide or individual unit basis shows less than a 0.5 dv improvement for most Class I areas including the four Class I areas located in New Mexico.
- Both the total annual costs evaluated and the cost-effectiveness ($/dv) are prohibitive given the minimal improvements realized.

Therefore, as previously noted, given the minimal visibility improvement to the class I areas in the BART analysis, the recommended BART control for SJGS is LNB, OFA, and a NN for NO_x control and PJFF for PM control.

ATTACHMENTS 1 & 2

OF NMED Ex. 7k

ARE ON CD ONLY